

Lawrence C. Sager
**Enhancing Tactical Decision-Making among Members
of Distributed Teams**

ABSTRACT

Network centric warfare offers increased connectivity, enabling smaller units to behave with greater independence and respond faster to changing operational contexts. But while greater connectivity may enhance situational awareness and improve tactical decision-making, it also threatens to impose information overload. To address this problem, this paper presents a model of **SWIFT** (Special Warfare Information Funneling Toolkit), a system concept enabling Navy SEAL teams to acquire, process, and share the information they need to collaborate in tactical decisions. SWIFT facilitates information delivery by enabling operation center systems and personnel to identify, prioritize, and map information needs onto available information sources. Information can thus be presented to a SEAL during a mission in a cognitively friendly format that is optimized for that person's roles and responsibilities; accounts for that person's geographical location; and fits the user interface capabilities of the hardware device with which he is equipped.

INTRODUCTION

The Problem

The U.S. Navy is undergoing a rapid transformation in the operations it conducts — the enemies it faces, the resources it draws on, the processes it uses, and the capabilities it delivers. This revolution began with the concept of “network centric warfare” (NCW) that is the basis of FORCEnet. It is evolving through the emerging information superiority initiatives outlined in Joint Vision 2010 and lessons learned in Afghanistan and Iraq. NCW offers increased connectivity across echelons, which will radically alter current operational concepts. It will enable smaller, lighter units to behave with greater independence and respond faster to changing operational contexts (e.g., Alberts, Garstka, and Stein, 1999; Alberts and Hayes, 2003). Nowhere is this capability more valuable than in Special Warfare, where small teams seek to move rapidly, flexibly, and decisively in response to unusual challenges.

Ultimately, network connectivity is only part of the solution to NCW. While greater connectivity may enhance situational awareness and improve tactical decision making, it also threatens to impose information overload. As the research literature amply proves (cf., Perry and Moffat, 2004), too much information can be just as detrimental to performance as too little. As information load increases, for example, people take stronger, and potentially riskier, steps to manage it, such as increasing their tolerance for error, delaying analysis, and filtering (Miller, 1978, chap. 5). Related to the concept of

information load is information *turbulence* – i.e., the frequency with which information changes, and the randomness of the change. When faced with high information turbulence, people must make trade-offs between comprehensive but time-consuming information processing versus relying on less comprehensive processes such as intuition and heuristics (Huber and Daft, 1987; Weick, 1995).

The danger is particularly critical for small teams operating on the battlefield. Rapidly emerging environmental threats, which may differ for each team member, compete for attention with information sharing and collaborative decision making activities. Among geographically-distributed teams, location-specific information that is highly useful to some team members (e.g., information on indigenous plants) may be irrelevant to others. High information load and/or turbulence can add to already stressful battlefield conditions, especially when the recipient is expected to assimilate the information quickly to perform a task. Although decision makers faced with increasing time pressure may turn to various heuristics to lower the cognitive effort required to perform a task, some heuristics may be more detrimental than helpful (Payne, Bettman, and Johnson, 1986; Tversky, 1969).

The Solution

The goal in this project was to design the SWIFT (Special Warfare Information Funneling Toolkit) service concept, a collaborative capability for SEAL teams to acquire, process, and share the information they need to collaborate in tactical decisions. SWIFT facilitates information delivery to SEAL personnel by identifying, prioritizing, and mapping information needs onto available information sources. The fundamental challenge addressed by SWIFT is the funneling of the right information to the right person at the right time, organized and presented in a cognitively friendly format. The products of this effort are innovative concepts for information processing operations and tools that fit within a total system solution for collaborative tactical decision-making. Efforts have been focused in particular on information exchange between the Tactical Operations Center (TOC) and SEAL platoons. A tight focus on TOC/Platoon collaboration has been ensured by designing to support realistic SEAL scenarios, as described by SEALs themselves in a series of group discussions, one-on-one interviews, and cognitive walk-through evaluations.

This project included an investigation of existing collaboration and information sharing tools (e.g., Georgia Tech Research Institute's FalconView and MIT's Ewall) to identify the extent to which the SWIFT system concept could be achieved through re-use of legacy components. That investigation is beyond the scope of this paper, which will henceforth focus mainly on accommodating end user needs through identification of useful system features and compelling user interface design techniques.

METHOD

The investigative method consisted first of interviewing Navy SEALs to develop an understanding of current practices, along with their needs and expectations, regarding

communication, collaboration, and decision-making tools and practices. Based on those findings, a model of the SWIFT system for tracking and managing information needs was created. Next, a storyboard prototype of the SWIFT concept was developed, demonstrating how SWIFT features will look and feel to end users. Through an iterative design process, the storyboard prototype was used to demonstrate SWIFT to key project stakeholders, solicit their feedback, and incorporate their suggestions into a revision of the prototype.

Highlights of the SWIFT System Model

A typical SEAL mission has at least three stages: Planning, Rehearsal, and Execution. It is assumed that **Mission Planning** occurs largely in or near the TOC, possibly using a large screen shared workspace to support activities that are mainly done face-to-face. As part of planning a mission, it is expected that the planning team will, in accordance with typical mission preparation methods (e.g., ArmyStudyGuide.Com, 2005), identify the mission objectives, commander's intent, alternate courses of action, and constraints. Our mission planning method augments these activities by expressly calling upon planners to identify the *information needs* associated with each task and laying out a *communication plan* to assure that the information needed to perform a task is delivered to the person responsible for task completion. If that information is relatively static and is available in electronic form during the planning stage (e.g., a terrain map), then it can be loaded onto a portable device (e.g., a PDA) before the mission commences and carried on the mission, thus eliminating any of the uncertainties associated with data transmission.

In other cases, the needed information may not be available until the mission has already begun – for example, an up-to-date weather forecast or information on enemy troop movements. The mission planners would therefore establish an *information prerequisite* for the affected task and identify the method and optimal time window for transmitting that information to the task performer's portable device. All this would be documented in the mission plan so that it can be tracked during mission execution.

A sample of the mission planning notation is shown in Figure 1. Tasks and objectives are depicted as ovals (the objectives have heavier borders than tasks) and information prerequisites are depicted as boxes adjacent to the affected tasks.

In recognition of the familiar adage “no plan survives first contact with the enemy,” the mission planning method encourages planners to consider alternative courses of action. It does this in two ways: (1) It enables planners to decouple mission *objectives* (i.e., desired end results) from mission *tasks* (the activities conducted to fulfill an objective), recognizing that there are usually multiple ways to achieve an objective; (2) the notational system expressly includes an “OR” logic operator, thus enabling planners to collaboratively diagram and discuss the pros and cons associated with alternate task sequences.

After planning is completed, preparations for mission execution take place, culminating in a **Mission Rehearsal**. The model recognizes that the rehearsal stage provides an

opportunity to walk through the mission with all key stakeholders prior to actual deployment, using support tools such as checklists to ensure that all preparatory activities have been completed, that all field personnel are familiar with the information that has been (or will be) loaded onto their portable devices, and that everyone understands the plan for generating and sharing information during mission execution.

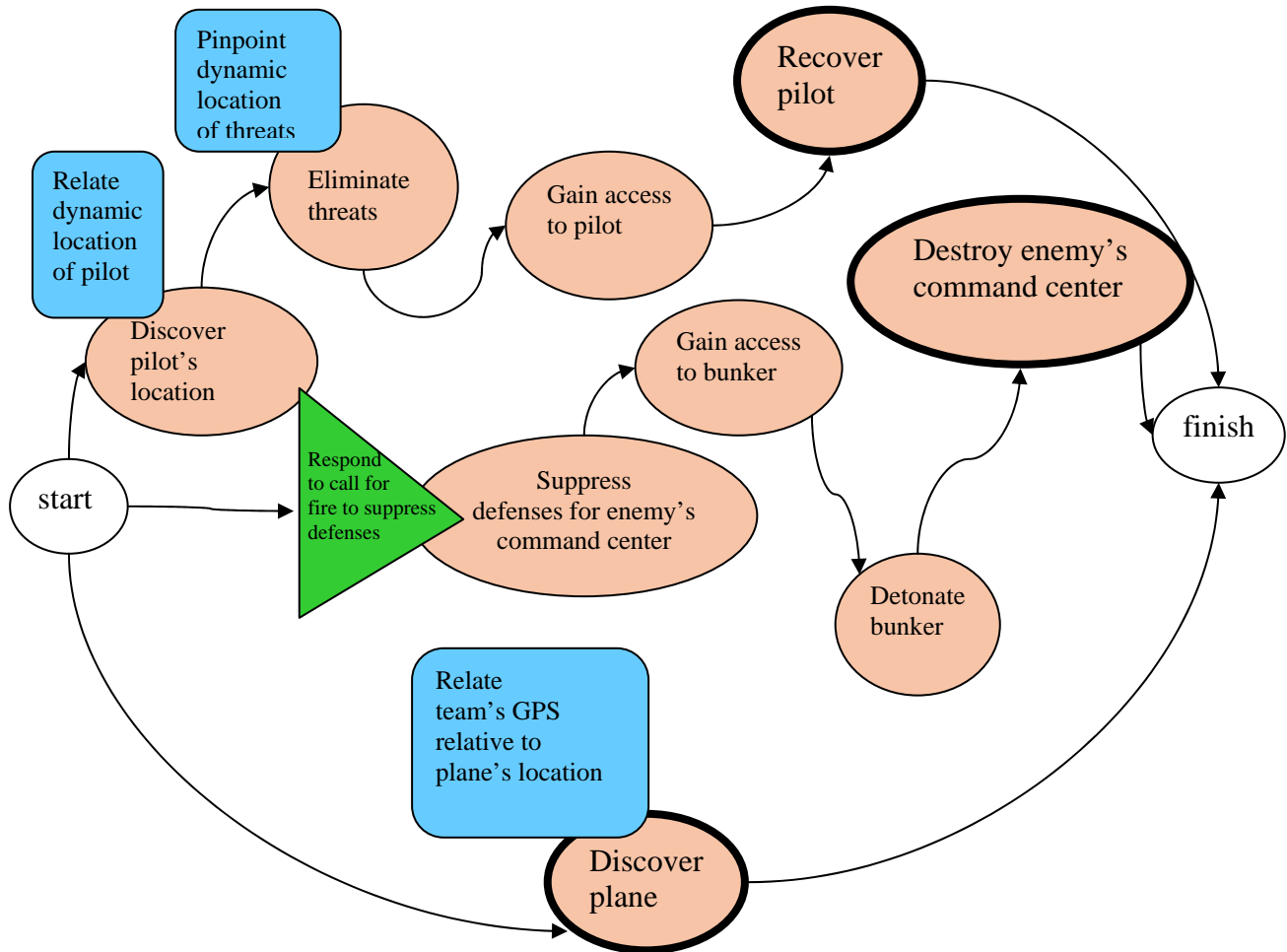


Figure 1: Information prerequisites (rectangles) for tasks (ovals with light borders) comprising a mission. Overall mission objectives are represented as ovals with heavy borders.

During **Mission Execution**, SEALs in the field carry a portable, PDA-sized communication device to monitor and report mission-related activities, receive information from the TOC, conduct analyses (e.g., with remaining water supplies, how far can they travel?), and if necessary, modify mission tasks. An email capability enables them to communicate and/or exchange information with other field or TOC personnel, thereby increasing the overall level of shared situational awareness across the entire team, and allowing for discussion of alternate courses of action before making any permanent changes to the mission plan.

In addition, by monitoring the location of each portable device (via an embedded GPS capability) and the progress of the mission, an *automated information retrieval system*

can continuously check for and send additional information that field personnel might need. For example, if a route change leads a team into an area with poisonous plants, the automated system could anticipate the potential risk and respond by proactively transmitting medical information. Even more importantly, if the automated system detects a critical outage in a mission plan (e.g., a key piece of intelligence will not be available soon enough to meet the deadline for task completion), it will alert the team members that certain tasks, or perhaps the entire mission, may be in jeopardy.

The danger in allowing an automated system to generate messages is that it could cause information overload. Hence, safeguards are in place to monitor each person's workload and restrict delivery of non-urgent messages when the recipient is presumed to be overloaded.

Highlights of the Storyboard Prototype

Central to the SWIFT service concept is the use of a small, portable communication and collaboration device by field personnel. Thus, a major design challenge was to assure that the functionality provided to these SEALs is usable on a typical PDA-sized display of approximately 3 ½ x 4 inches. The iterative storyboard design process was key in helping to identify and resolve user interface issues. Ultimately, a family of display tools was developed that could support the SWIFT features, including such things as:

- A mailbox capability for transmitting and receiving information.
- A mission roadmap to represent objectives, tasks, and information prerequisites.
- A mapping capability to depict geographical references, routes, and boundaries.
- A library of information (e.g., foreign language dictionary, medical reference material, etc.) that might be needed during a mission.
- A “dashboard” to provide at-a-glance indication of overall mission status without causing cognitive overload.

Space does not permit discussion of all the solutions to small-display problems that were identified, so a sample of two solutions is presented below.

Awareness of off-screen map objects

When viewing a large graphical surface area, such as a map, the user faces the problem of zooming out to view the entire map surface but losing detail, versus zooming in to see detail but losing the context of the total map surface. One solution to this dilemma is to use the technique of “halos” to signal the presence of off-screen objects of interest (Baudisch and Rosenholz, 2003). As shown in Figure 2, a halo is presumed to encircle all off-screen objects. The halo expands/contracts in diameter so that at least a fragment of every halo appears on whatever portion of the map is in view. Thus, in addition to signaling the existence of an object, the halo can also signal (a) the direction to the object, (b) the distance to the object (the farther the distance, the larger the radius of the halo), and (c) the state of the object (via the color, thickness, dash style, etc. of the line comprising the halo.)

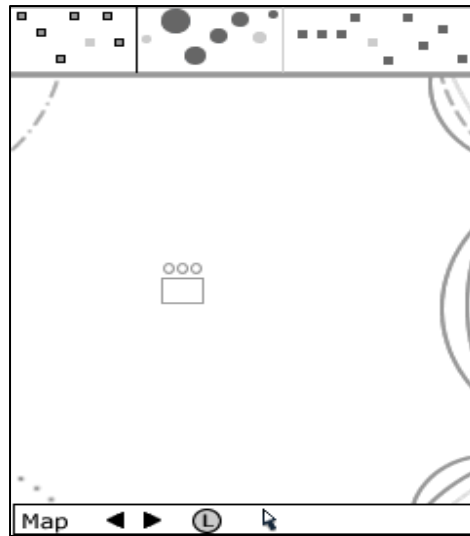


Figure 2: Halos signaling off-screen objects.

Representation of a mission plan

Another challenge was to find a way to visually represent the elements of a mission plan in a more compact format than was shown in Figure 1. The solution appears at the top of Figure 2, using what appears to be an array of different-sized circles and squares. A more detailed view is shown in Figure 3.

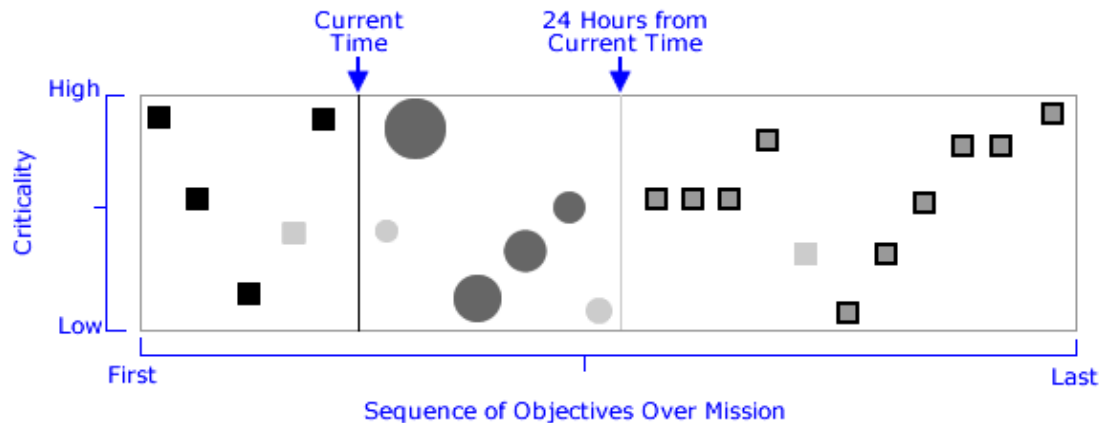


Figure 3: Representation of mission planning elements.

The following information can be conveyed with this notational scheme;

- Mission tasks. The geometric objects in Figure 3 (circles, squares) represent tasks. Those due for completion within the next 24 hours are shown as circles.
- Time sequence. The horizontal dimension represents time.
- Criticality. The vertical dimension represents the importance of a task to the overall success of the mission. Thus, given limited time or resources, the SEAL team should focus on the tasks with the highest criticality level.

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- Tasks in jeopardy. Tasks that are overdue, or in jeopardy of not being completed on time, are shown in a contrasting color or shade.
- Proximity to task location. Within the “today” region of the display, the diameter of task circles represents the distance of the SEAL team from the location where the task is expected to take place.

Using the PDA’s pointing device, the user can point to any of the task objects and cause a popup window containing task details to appear.

Although this notation method packs a large amount of mission information into a small display area, one visual element seen in Figure 1, line segments representing predecessor/successor relationships between tasks, is not included. This omission is deliberate, as it was found that the segments contribute to excessive screen clutter. Instead, relationships between tasks are described only in the popup detail window.

CONCLUSION

The SWIFT service concept and associated screen design techniques have been reviewed by various subject matter experts and judged to be both technically feasible and of value in addressing the information planning and exchange needs of the SEALs without subjecting field personnel to problems of information overload.

This work is applicable to other military domains as well. In general, any type of mission that involves precise coordination of activities and information flow between geographically dispersed units, operating under conditions of high uncertainty and rapidly changing circumstances, could benefit. Undersea applications, for example, might include insertion/extraction of special forces personnel via submarine; or precision strike against shore targets by an integrated strike force, with targets communicated to them just-in-time while at sea.

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Lawrence Sager, Ph.D. is a senior human factors engineer with Aptima., Inc., where his current research focuses on the design of tools and methods to improve communication and collaboration within hierarchical teams. Dr. Sager has over 20 years of experience in planning, designing, and evaluating complex human-machine systems and service operations. Prior to joining Aptima, Dr. Sager worked at AT&T, where he held the positions of human factors consultant, systems engineer, and project manager. Dr. Sager also worked at VocalTec Communications as the director of project management, and at Vonage Holdings as the leader of the systems engineering and project management teams. Dr. Sager holds a Ph.D. in Cognitive Psychology from the Johns Hopkins University and a Master's Certificate in Project Management from George Washington University.